Pawlak R, Kolasa KM. Embracing a plant-based diet. What is it and what is the evidence? Nutrition Today. 2017;52(3):155-161 Final version published at https://journals.lww.com/nutritiontodayonline/pages/default.aspx

Embracing a plant-based diet. What is it and what's the evidence?

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No funding was received for this manuscript.

Running title: plant-based diet

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ABSTRACT

In this paper we present a case of a young health professional feeling peer pressure to become vegan. We also present a case of a vegan baby. We discuss nutrient of concerns for individuals restricting or eliminating animal food from their diets.

INTRODUCTION

Virtually all diets consumed in the U.S. are plant based (Table 1). However some are more so than others. Some diet plans (1) limit or restrict (e.g. semi vegetarian, Mediterranean, DASH) while others eliminate most or all animal foods (e.g. ovo-lacto vegetarian, vegan). At the same time individuals in the US also restrict limit or eliminate other foods both plant and animal based either a food or ingredient (e.g. sugar), by a production method (e.g. organic farming), or component (e.g. gluten, lactose, additives). The more that these restrictions, limitations or eliminations apply, the more difficult it is for an individual to ingest essential nutrients without fortification, enrichment and very careful meal and snack planning. There is some evidence that individuals who adopt the most restricted diets (e.g. whole food plant-based diets (2)) tend to have the most and most deeply held beliefs (6,11). They alter their lifestyles for environmental, health and/or religious reasons. Some of these life style changes such as prohibitions on smoking and alcohol consumption have important benefits on health. Restricting or eliminating animal food without adequate knowledge and attention to food composition and nutritional requirements can lead to negative health consequences. It may be difficult for health care professionals to address these concerns if individuals reject conventional medical care (e.g. vaccinations, anticipatory guidance from health professionals) or disregard scientific publications.

In this paper we present two cases from our practice highlighting the evidence to support the health benefits, debunk some myths but also raise cautions of following a vegan or vegetarian

eating approach, regardless of an individual's motivation for adopting a plant-based way of eating. We discuss planning how to provide adequate amounts of the nutrients "of concern, especially vitamin B12 and iron.

CASE 1

John, a 3rd year medical student, asks his primary care preceptor for advice about diet. He's had limited nutrition training and little motivation to learn about nutrition on his own. He began "working out" at the gym with friends who follow the Paleo diet in the belief it will help them build muscle. The Paleo diet is a popular eating approach that is typically high in fat and animal protein and low to moderate in the products of agriculture. He's heard from Registered Dietitian Nutritionist (RDN) faculty member that the Paleo is not evidence-based. John's new girlfriend is a vegan and she wants him to change. While he studies, she is active on social media and follows several "clean eating" bloggers. His readiness to give up eating meat, fish, poultry, dairy and fast foods is low. However, he feels like he should be a role model for his patients and assumes being a vegan is healthy.

John's weigh is in the normal range (BMI = 23.6) but wants to gain 10 pounds of muscle. His waist circumference (32.5 inches) puts him in a low risk category for metabolic disease. He has a low resting energy expenditure calculated at 1,738 kcal with an estimated 800 kcal of activity per day. An example of his current diet includes: Breakfast: smoothie (mixed berries, almond milk, Greek yogurt, protein powder, chia seeds, apple cider vinegar); Lunch: meat entrée and veggies in the hospital cafeteria or pizza; Dinner: fast food and Mt Dew or energy drink.

His grandmother was vegetarian while in college in the 1970s and expresses concern that John doesn't have time to ensure he gets all the essential amino acids by planning to complement proteins at each meal. John's "gym rat" friends tell him vegans can't get enough protein to build muscle mass. How would you counsel John?

BACKGROUND

Motivations of dietary choices.

Since the late 1990's there's been a convergence of scientific opinion on the safety and healthfulness of appropriately planned plant-only diets with plant-based diets that include animal products (7). It was recognized that plant-based diets can be adequate in the nutrients they lack by complementation, fortification and supplementation. In recent years the criteria for healthy eating has moved beyond nutrient adequacy and avoidance of deficiency to include balance, and reducing risks for chronic disease. In 2016, the Academy of Nutrition and Dietetics stated that the adoption of a vegetarian diet may cause a reduced intake of certain nutrients; however, deficiencies can be readily avoided by appropriate planning (8).

In the United States vegetarian and vegan eating patterns have traditionally fallen outside of the accepted eating patterns. However, in recent years they have been included in the Dietary Guidelines for Americans (1). The 2015-2020 Dietary Guidelines for Americans include 5 principles: 1) Follow a healthy eating pattern across the lifespan, 2) Focus on variety, nutrient density, and amount; 3) Limit calories from added sugars and saturated fats and reduce sodium; 4) Shift to healthier food and beverage choices and 5) Support healthy eating patterns for all (1). The 2015-2020 DGAs include recommendations for the DASH and Mediterranean eating approach which are plant-based, as well as vegetarian patterns that are plant only (9). At the same time, there has been growing interest in plant-based diets for reasons beyond health of the individual to include popular dietary trends, the health of the planet, ethical and religious considerations. Understanding the motivations of a patient to follow a plant-based diet could help the counselor focus the content of a medical nutrition therapy session as well as the individual's willingness to accept evidence based advice.

In 2010, Pribis and coworkers (10) reported that there are significant differences across generations as to why people choose to live a vegetarian lifestyle, with people under the age of 20 years choosing the lifestyle for moral (e.g. it is wrong to kill animals) and environmental (e.g. protective of the planet) reasons; with older persons, ages 41 to 60 years expressing health reasons (e.g. live longer with less sickness). Among Seventh—day Adventist, faith or living consistent with the Adventist lifestyle is a strong motivator.

Researchers have attempted to describe how the motivation to follow a vegan or vegetarian eating approach might impact an individual's nutrient intake or health. Hoffman and coworkers described the differences in conviction, nutrition knowledge, dietary restriction, and duration of adherence to vegetarianism between the vegetarians for health reasons versus vegetarians for ethical reasons through an online survey of about 500 individuals (11). They found ethical vegetarians scored higher on a conviction instrument and consume fewer animal products, exhibited somewhat greater dietary restriction and had been vegetarian for longer than health-minded vegetarians. Surprisingly, nutrition knowledge did not differ between the two groups. De Baker and Hudders (6) explored vegetarians' and semi-vegetarians' motives for reducing their meat intake. They categorized participants as vegetarians (remove all meat from their diet); semi-vegetarians (significantly reduce meat intake: at least three days a week); or light semi-vegetarians (mildly reduce meat intake: once or twice a week). Animal-rights and ecological concerns, together with taste preferences, predicted vegetarianism, while an increase in health motives increased the odds of being semi-vegetarian.

Today's discussion about plant-based eating is complicated by other eating trends including "eating clean" made popular by celebrities and bloggers and promoted in restaurants, restaurants and magazines. While no single definition exists, the principles of "eating clean" appear to be: eat more vegetables; choose whole grains; eliminate refined sugars and processed food; reduce salt intake; reduce alcohol. For some, "clean eating" would also be gluten-, dairy- and soya- free. The ultimate "clean eater" would follow all these principles and be vegan who eats organic and prepares most food at home.

Evidence for the risks and benefits of consuming a DASH, Mediterranean, and whole food plant-based including vegan and vegetarian diet

DASH and Mediterranean Eating Approaches. The evidence to support the effectiveness of following the DASH eating plan to prevent and/or treat many chronic diseases and obesity is robust and has grown since its introduction in 1997 (1). Benefits include but are not limited to: a net effect on blood pressure of -7.62mm Hg systolic and -4.22 mm Hg diastolic; weight loss and reduction in blood pressure in African Americans of up to 35 pounds; a drop in LDL-C of about

0.3 to 0.4 mmol; a drop in triglycerides of about 14-18 mg/dL; depending on other factors a rise in HDL-C up to 10 mg/dL; improvement in insulin resistance and lowering fasting blood sugar by 8-15 mg/dL; a reduction in bone turnover; a reduced risk of heart failure for those with high blood pressure; a reduction of kidney stones; and a possible reduced risk of depression. The impact of the diet on the health of children has been less well studied but is thought to confer health benefits. In 2016, the US News & World Report magazine called DASH the best and healthiest diet (12). The plan includes daily 10 servings of fruit and vegetables (need not be fresh); 8 servings of grains; 3 servings of low fat dairy; less than 6 ounces of meat, fish, poultry; and 4-5 servings of nuts/week. While little is known about sustained benefits of following a DASH diet, the ENCORE study, a 16 week intervention with one year follow up, demonstrated that even with some back sliding on weight loss, a positive blood pressure effect persisted (13).

The Mediterranean eating plan is growing in popularity and ranked Number 2 by US News (12) has a less robust data base than DASH, in part because there is no single definition of the Mediterranean diet as consumed in the US. Additionally, most of the available data come from outside the U.S. Generally, the study results report reduced inflammation and reduced cardiovascular risk (14). In US studies researchers report reduced frailty risk and reduced metabolic syndrome in the population (14-15). The Mediterranean diet has been described as a plan with an abundance of food from plant sources with an emphasis on a variety of minimally processed and, wherever possible, seasonally fresh and locally grown foods. Olive oil is the principal fat with total fat ranging from less than 25% to over 35% of energy and saturated fat no more than 7 to 8% of energy. It includes daily consumption of low to moderate amounts of cheese and yogurt and twice-weekly consumption of low to moderate amounts of fish and poultry—with fish be somewhat favored over poultry; and up to 7 eggs per week (including those used in cooking and baking). Fresh fruit is the typical daily dessert and red meat is limited to a few times per month. Regular physical activity at a level which promotes a healthy weight, fitness and well-being are encouraged. Moderate consumption of wine, normally with meals; about one to two glasses per day for men and one glass per day for women is allowed (1, 16).

Whole Food Plant-Based Eating. In the 2011 film "Forks over Knives, physicians made the claim that most, if not all, of the degenerative diseases that afflict us can be controlled, or even reversed, by rejecting animal-based and processed foods (17). The definition of a whole-food, plant-based diet found on the "Forks over Knives" website is, "A whole-food, plant-based diet is centered on whole, unrefined, or minimally refined plants (17). "It's a diet based on fruits, vegetables, tubers, whole grains, and legumes; and it excludes or minimizes meat (including chicken and fish), dairy products, and eggs, as well as highly refined foods like bleached flour, refined sugar, and oil." This definition also has been used by Lifestyle Medicine clinicians (18). Surprisingly, there are few data to support the health benefits of vegetarian, vegan and whole-food plant-based diets. A Pub Med search conducted in October 2016 using the term "vegetarian" yielded 820 studies, almost half of which were published before the year 2000. A search using the term "vegan" identified 186 studies with about 25 percent published before 2000. A search using the term "plant based diet" yielded 66 publications with 3 percent published before 2000 and only two used "whole-food plant-based" diet in the title or abstract (Table 1). It is important to point out that among the matched manuscripts there are reviews, commentaries, position papers, case reports, letters and editorials. Several researchers studied fish or other animals. Thus, the number of original research reports is considerably smaller. It is also important to note that the data are primarily from outside of North America.

To help guide our patient in determining if following a vegan, vegetarian or semi-vegetarian eating plan would provide more health benefits than DASH or the Mediterranean approach, we will focus the rest of this paper on the available evidence. The literature will include vegetarian diets that include processed foods, additives and plants grown either conventionally or organically. We are mindful that Dwyer when summarizing a panel discussion at the 1999 Third

International Congress on Vegetarian Nutrition about the safety, efficacy, advantages and disadvantages of plant-based and plant-only dietary patterns ended with the admonition that scientists must respect dietary freedom and diversity when making recommendations (7).

Evidence of benefits and risks. Most of our understanding of the health benefits and risks come from four large studies. The Adventist Mortality study with 24,538 subjects of which 10,258 were vegetarian produced 58 publications from 1956-2014. The Adventist Health Study yielded 112 publications between 1988 and 2015 with 8,003 vegetarians out of the total 28,952 participants. The Adventist Health Study II with 96,194 participants led to 29 publications between 2007 and 2016. The Epic-Oxford study with a total population of 65,429 of which 21,436 were vegetarians (18,840 Lacto-Ovo-Vegetarian; 2,596 Vegan) produced 57 publications between 2000 and 2016. The Oxford Vegetarian Study had 11,047 participants with 4,674 vegetarians.

From these and the other literature we can classify the evidence of health benefits from strong to weak for a variety of conditions (Table 2). The strongest argument can be made for improved cardiovascular risk factors. For many other conditions there are very limited data. Trepanowski and Varady (32) compared the effects of a low fat vegan diet as well as a vegan diet that contained prescribed amounts of plant sterols, viscous fibers, soy protein and nuts to the eating plans recommended by the American Diabetes Association (ADA) and the National Cholesterol Education Program (NCEP). They concluded that a low fat vegan diet might improve glycemic control better than the ADA and a vegan portfolio diet may improve blood lipids better than the NCEP plan in hypercholesterolemic adult.

If poorly planned, the evidence that following a vegetarian and/or vegan diet could increase risk of vitamin B12 deficiency is strong (33-35). Symptoms may include neurologic, psychiatric, hematologic, and dermatologic abnormalities (33-35). A variety of neurological symptoms may occur and vary from one individual to another. The onset of symptoms is often experienced first in legs and they are more severe in legs than arms (33-35). These symptoms often, though not always, progress in the following manner. Parasthesia (abnormal sensation felt in legs, most often tingling and prickling also described as feeling pins and needles) is noticed first in the feet,

which then spreads to legs, and may also occur in arms. Muscle weakness, coordination disturbances, numbness and/or tremors are manifested next. If left untreated, paraplegia (paralysis) may occur (33-35). While some believe that protein adequacy is of concern, the actual nutrients of concern for vegetarians and vegans include iron, Omega 3 fatty acids (DHA, EPA), calcium and vitamins D and B12 (8). Since our patient is concerned about protein, we note that in the past, many introductory nutrition text books warned vegetarians that they must complement plant proteins at every meal to ensure that all nine essential amino acids were ingested. This belief, along with the concern that vegetarians, especially vegans and vegan athletes, may not consume an adequate amount and quality of protein are unsubstantiated. Consumers do not need to be concerned about amino acid imbalances when consuming the plant based proteins when a mixture of plant foods, such as legumes, grains and nuts is ingested. (36).

CASE REVISITED

We described to John the important health benefits that can be achieved by following a plant-based or semi vegetarian diet such as DASH. We talked with him about the limited data about any additional health benefits that would be achieved by becoming a vegan and that there are some health risks if the diet is not well planned. We told John that if he ingests a variety of grains, fruits, and vegetables (including legumes, nuts and seeds) he will ingest adequate amounts of protein, carbohydrates and dietary fiber but he may not get adequate amounts of direct sources of long chain essential fatty acids (EPA & DHA) or vitamin B12 and would need to monitor his need for supplements. As a young adult he might consume enough foods and beverages that are fortified with vitamin B12 and not need a supplement. The dose of vitamin B12 needed varies and it mainly depends on age, medical condition and life stage. As a young adult, a weekly 250 μg supplement might be sufficient to maintain adequate B12 status. If he becomes vegan, especially if he joins his girlfriend in "eating clean" and avoiding processed foods, he also would likely need a larger dose of vitamin B12 and 500 mg/day of a combined algal DHA and EPA.

John wants to take some time to read the studies and think about his motivations for becoming a vegan and how he might counsel his friends and future patients. In the meantime he thinks he should improve his diet and asks for some ideas on how to shift toward plant-based diet. He sets as a goal to eat at least one more serving of vegetables a day and to at least taste the grains and legumes his girlfriend is preparing. We supply him with materials that both he and his patients might like from MyPlate (1). We encourage him to explore the materials on the Vegetarian Resource Group Web page (www.vrg.com) as well. He has agreed to keep a food record for two weeks and return for a visit with RDN to review his progress.

CASE 2

BJ has brought her 18 month old son, Josh, for Medical Nutrition Therapy (MNT) appointment at the insistence of her mother. BJ doesn't think they need the appointment but hopes her mom will stop nagging her about raising a vegan child. The baby's grandmother is a 70 year old retired physician who during her residency training treated a malnourished vegan infant. BJ insists that she "knows what she is doing" and she is not like the parents who are charged with endangerment of their children or homicide for starving their babies by feeding only wheat grass, coconut water and almond milk.

Josh was exclusively breastfed for 12 months and continues to receive comfort feedings. BJ took vitamin B12 supplements while breastfeeding and had her vitamin B12 status assessed during pregnancy and lactation. BJ reports that she feeds Josh grains, legumes, nuts and/or seeds, fortified soy milk, vegetables and fruit every day. She puts a bit of healthy fat into his cooked cereal or on a slice of bread. BJ believes that living a vegan lifestyle can be healthy and also protect the planet. BJ and her husband have been practicing veganism for three years. Josh's grandmother is concerned because Josh is "small" and doesn't talk yet. She wants to have Josh's B12 level checked and his diet reviewed for nutrient adequacy.

BACKGROUND

Professional position statements.

"Appropriately planned vegetarian, including vegan, diets are healthful, nutritionally adequate, and may provide health benefits for the prevention and treatment of certain diseases," states the Academy of Nutrition and Dietetics (AND) in its 2016 position paper (8). The Academy states further "these diets are appropriate for all stages of the life cycle, including pregnancy, lactation, infancy, childhood, adolescence, older adulthood, and for athletes." The American Academy of Pediatrics' book "Pediatric Nutrition" devotes a chapter to vegetarian and vegan diets and quotes the AND position (37). However not all professional societies agree. The German Nutrition Society's (38) position is that, "With a pure plant-based diet, it is difficult or impossible to attain an adequate supply of some nutrients. The most critical nutrient is vitamin B12. The GNS does not recommend a vegan diet for pregnant women, lactating women, infants, children or adolescents (38). Similarly, the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition stated that vegan diet have generally been discouraged during periods of complementary feeding.

Limited data describe risks and benefits of vegetarian/vegan diets for children.

Few studies of vegans and vegetarians include infants and children. A Pub Med search conducted in November 2016 using the term "vegetarian" and limiting it to infants, children and adolescents yielded 80 studies of which almost half (46%) were published before the year 2000. A search using the term "vegan" identified 12 studies with half (50%) published before 2000 (Table 1). Jacobs and Dwyer (39) published a small body of work in the 1970's and 80's that provide some insights into the possible benefits and risks of raising a vegetarian or vegan infant or child in the U.S. The FARM study is perhaps the most commonly cited work, published in 1989 it documented that by the age of 10 years, children from this vegan community in Tennessee attained adequate growth even though slightly less than the reference (40).

Pawlak (41) listed the benefits of following a plant-based diet for infants and children as: adequate birthweight and growth; lower risk of obesity; lower exposure to environmental

pollutants such as mercury, lead, cadmium, PCBs (polychlorinated biphenyls), DDT and polycyclic aromatic hydrocarbons (PAH). The risks include: deficiency of vitamin B12, iron and essential fatty acids (EPA & DHA); vitamin B12/hyperhomocysteinemia (HHCY) related complications, which may include: developmental delays; neurological problems; hematologic abnormalities; neural tube defects; and hypospadias, a birth defect in boys in which the urethra doesn't develop properly. Most experts agree that the key nutrients of concern for infants are vitamins B12 and D, as well as iron, zinc and calcium.

The symptoms of vitamin B12 deficiency in infants/children are listed in Table 3. Today, clinicians have a heightened suspicion to symptoms of Autism or Asperger syndrome, which may mimic those of vitamin B12 deficiency, and may not consider a vitamin B12 deficiency as a cause of the symptoms. For breastfed infants of vegetarian/vegan mothers it is important to ensure breastmilk provides sufficient vitamin B12 or that breastfed infants receive supplements of 0.4-0.5 micrograms of vitamin B12 daily (41).). It is recommended that the vitamin B12 intake of vegan infants and children should be assessed and fortified foods and/or supplements used as necessary to insure adequacy (8Melina, Pawlak).

Appropriately planned vegan diets for infants, children and teens.

Appropriately planned vegetarian and vegan diets for infants, children and teens have been described in vegetarian diet guide books (42-44). These diet plans demonstrate how to use foods and supplements, when needed, to ensure vitamins B12 and D, iron, zinc and calcium and omega 3 fatty acid needs are met. As with vegetarian/vegan adults in the U.S. protein intake is typically not a concerns since it has been well documented that the protein intakes of vegetarian children meet or exceed recommendations (8, 41).

The foods and beverages included in diet plans for vegetarian/vegan infants, children and teens are not typical for omnivore children. They include: fortified soy milk, mashed tofu and legumes, tempeh, meat analogs, quinoa, amaranth, wheat germ seed butters, flaxseed oil, nondairy milks, blackstrap molasses, figs, and nutritional yeast. Vegetarian/vegan children tend to have a broader range of fruits, vegetables and grains than omnivore children. The diets need reliable sources of vitamin B12 to meet the Recommended Dietary Allowances for Vitamin B12 for

male and female infants: 0.4 mcg (0-6 months), 0.5 mcg (7-12 months), 0.9 mcg (1-3 years), 1.2 mcg (4-8 years), 1.8 mcg (9-13 years) and 2.4 mcg (14+ years) (45). Vitamin B12 is generally not present in plant foods although found in some fortified foods. Reliable sources of vitamin B12 include: breast milk (assuming adequate vitamin B12 status of mother), foods fortified with "cobalamin" or "cyanocobalamin" (e.g. breakfast cereals, soy beverages, soy meat substitutes, nutritional yeast). Chlorella, fermented foods, seaweed, algae, and spirulina are not reliable sources (45). Infants, children and teens, and adults with limited intakes are at risk of a deficiency should check their vitamin B12 status periodically.

Vitamin B12 status

Symptoms of Vitamin B12 deficiency in children. Table 3 summarizes the symptoms of vitamin B12 deficiency as seen in children. In adults, simple physical and sensory evaluations such as walking down a straight line is a good way to assess for the presence of neurological symptoms. Assessing the presence or absence of Babinski sign or reflex is another assessment technique that works well on any age and there are "primitive reflexes" that can be tested in infants that are worrisome if they don't disappear. General reflexes and clonus are "easily" tested in all ages. Tandem walk (heel-toe), nose-finger pointing, Rhomberg, rapid alternating finger closure and heel/shin rubbing can be routinely tested in kids around three years of age (if the child is cooperative and person doing the assessment is creative) to assess for balance, eye-hand and cerebellum function. Having a person stand with his/her feet close together, and seeing if he/she can remain standing without moving, is yet another simple neurological test. The following link contains a video with simple neurologic tests https://www.youtube.com/watch?v=RAQycLXSFrU. I would like to propose the delete this section and instead state that: infants and children diagnosed with B12 deficiency or who are suspected as having B12 deficiency should be referred to a neurologist to perform neurological assessments and propose the course of treatment. This will reduce the info on B12.

Laboratory assessment of vitamin B12. At the present time, there is no gold standard for assessing vitamin B12 status (45). Tests used are listed in Table 4. The mean corpuscular volume value (MCV) as part of the complete blood count (CBC) is often used but this test is

neither specific nor sensitive (35). Rather, at least two biomarkers of B12 status should be used to obtain reliable picture of B12 status. Different researchers use different deficiency cutoffs when interpreting the results of serum vitamin B12 or homocysteine concentrations (48). Methylmalonic acid (MMA), in general, is considered sensitive marker of B12 status (33). Homocysteine (Hcy) in the presence of adequate folate intake is also sensitive of B12 status (48). The most accurate way to assess vitamin B12 status includes urinary or serum MMA and/or holotranscobalamin II (holoTCII) (33, 49-50).

Treatment of low Vitamin B12. There is no standard treatment of vitamin B12 deficiencies but rather a variety of approaches derived from published case studies (45). Low levels can be treated with intramuscular injections or Vitamin B12 supplements. In dietary supplements, vitamin B12 is usually present as cyanocobalamin but might also contain methylcobalamin and other forms of vitamin B12. Absorption and bioavailability appear to be the same regardless of form. Vitamin B12 in the form of cyanocobalamin can be administered by intramuscular injection, as is the case for other vitamin B12 forms such as hydroxocobalamin. The dosage varies from 100-1,000 ug/day to week and changes over time of treatment.

Iron

According to the World Health Organization (WHO), normal birth-weight, exclusively breastfed infants who are younger than 6 months do not need iron supplements. However, during complimentary feeding after the first 6 months of age, infants should receive foods that have been fortified with iron. WHO has also recommended to use iron supplements in order to prevent and to treat iron deficiency anemia. In anemia prevention, WHO recommended the amount of 2 mg/kg body weight/day among children 6 to 23 months, and 2 mg/kg body weight/day not to exceed 30 mg and for children 24 months through school years. For iron deficiency anemia treatment WHO recommended 3 mg/kg body weight/day not to exceed 60 mg/day for infants and young children.

Iron status can be assessed using hemoglobin (Hb) level. WHO iron deficiency anemia criteria cutoff include <110 g/L for children 6 to 59 months, <115 g/L for 5 to 11 years old and <120 g/L for those 12 to 14 years old. **World Health Organization. Iron Deficiency Anaemia**

Assessment, Prevention, and Control A guide for programme managers. http://www.who.int/nutrition/publications/en/ida_assessment_prevention_control.pdf?ua=1 . Accessed 11/13/2016..

Other nutrients

Recent research showed benefits of adequate supply and status of a few additional nutrients including EPA, DHA, vitamin D and choline. To date, no research has been published to evaluate the impact of these nutrients in vegetarian children on their health status. EPA, DHA and choline status depends on dietary intake, while vitamin D status depends, mainly, on sunshine exposure. Vegetarian children may have lower intake and status of EPA, DHA and choline due to having limited dietary sources of these nutrients. Algal EPA and DHA supplements may be utilize to improve intake and status. Eggs and dairy products intake will enhance choline status. Adequate sunshine exposure and/or utilizing vitamin D fortified foods and/or supplements will help to maintain adequate vitamin D status.

Case revisited.

We reassured BJ and her mother that a well-designed vegetarian and vegan diets can meet nutritional needs of infants, children and adolescents if fortified foods and/or supplements of key nutrients (vitamin B12, EPA, DHA and iron) are utilized. We assessed BJ's nutrition knowledge and found she was committed to using dietary guidance from reputable sources. To calm the grandmother's fears related to delayed speech, BJ requested that both Josh's and her vitamin B12 status be assessed and they were found to be in the normal range. We offered her some additional nutrition education resources.

SUMMARY

There is strong evidence that moving toward consuming a plant-based diet can reduce factors for many chronic conditions. As an adult or child restricts foods, especially animal foods, there is the potential for creating nutrient inadequacy. Vegetarians and vegans need reliable sources of

vitamin B12. RDNs and other health care professionals providing care to individuals interested following plant-based diets should be prepared to understand the motivations of the patient to follow a plant-based diet and be able to discuss health risks and benefits of the diet chosen by the patient.

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ACKNOWLEDGEMENT

We appreciate the assistance of Gina C Firnhaber MSN, MLS, MPH, RN, Research Librarian, Information Specialist with Laupus Health Sciences Library, East Carolina University, Greenville, North Carolina with the literature review.

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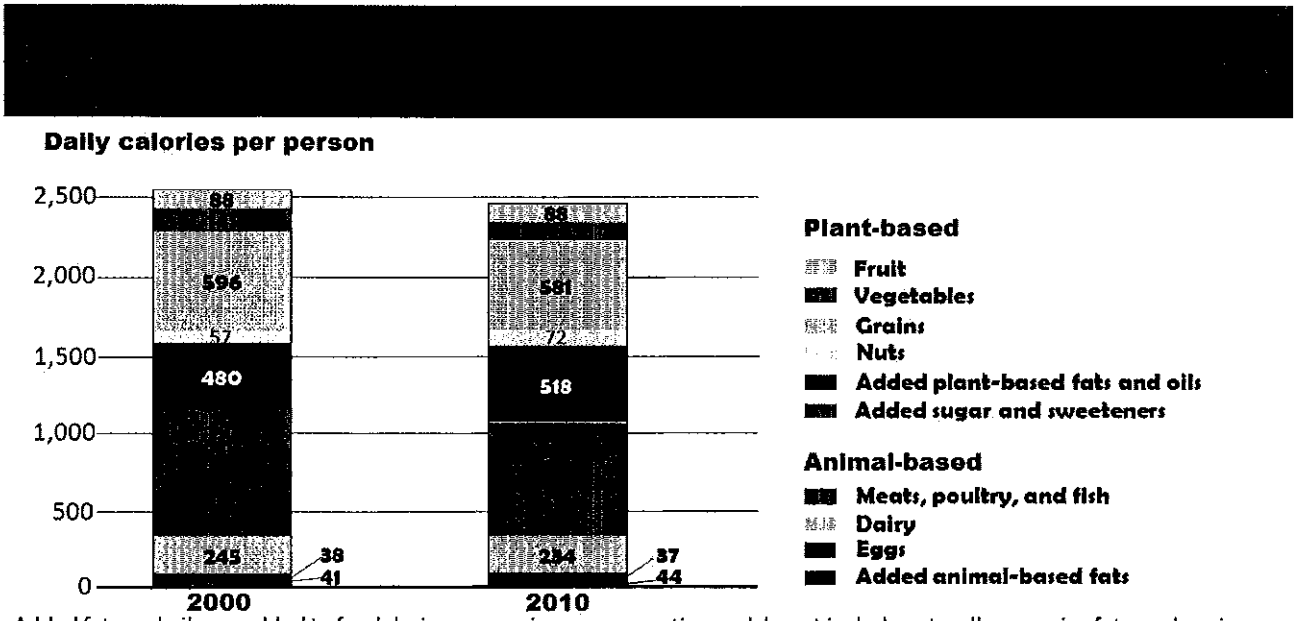
TABLE LIST

Table1. Pub Med search for vegetarian, vegan plant-based diets

Figure 1. Sixty percent of U.S. calories consumed in 2010 were from plant based food (1).



Added fats and oils are added to food during processing or preparation and do not include naturally occurring fats, such as in meat, dairy products, nuts and avocadoes. Added animal-based fats include better, lard, and edible beef tallow.
Source: USDA, Economic Research Service Loss-Adjusted Food Availability data. https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=81864.

Table 2. Plant Based Diet and rating of evidence for reducing risks for selected conditions in adults

Condition	Level of Evidence	Reference Number
Improve cardiovascular disease		
risk factors	strong – fair*	18-19
Weight status (high BMI)	strong	20
Blood glucose and HgA1c	fair*	21
Risk of Ischemic Heart Disease	fair*	22
Reverse atherosclerosis	fair*	23
Most types of cancer	fair*	24
Cataract	weak*	25
Diverticular disease	weak*	26
Crohn's disease	weak*	27
Overall and disease specific mortality	fair*	28-29

*rating primarily because of limited data—need quality studies

Table 3. Selected symptoms of vitamin B12 deficiency in the pediatric population

Category	Symptoms
Anthropometric	Developmental delays/fall in growth curves --weight <10th percentile -height < 10^{th} percentile -head circumference < 10^{th} percentile Unable to sit alone Unable to walk Involuntary movements Hyperpigmentation Abnormal fine and gross motor functions
Hematological	Elevate MMA Elevated Hcy Low or "normal B12 Pancytopenia (low count of all blood cell types) Low or subnormal RBC, WBC, Platelets
Other	Anorexia Failure to thrive Lethargic Lack of responses to stimuli/interaction with people Hopotonic Muscular weakness Involuntary movements Slow/abnormal EEG Delays in speech development

Table 4. Reference values for vitamin B12 biomarkers.

Assessment	Traditional assessment cutoffs	Evidence-based assessment cutoffs	Reference Number
Serum B12	>147 pmol/L (>200 pg/ml)	>300 pmol/L (>405 pg/ml) or >400 pmol/L (>542 pg/ml)	36-37
Homocysteine	<15 µmol/L	<10 µmol/L	38
Holo TC II	>35 pmol/L	>65 pmol/L	39
Serum MMA	<260 nmol/L or <271 nmol/L	<260 nmol/L or <271 nmol/L	33
Urinary MMA	<4.3 µmol/L creatinine	<4.3 µmol/L creatinine	40
MCV	80 – 98 μm^3/cell	80 – 98 μm^3/cell	